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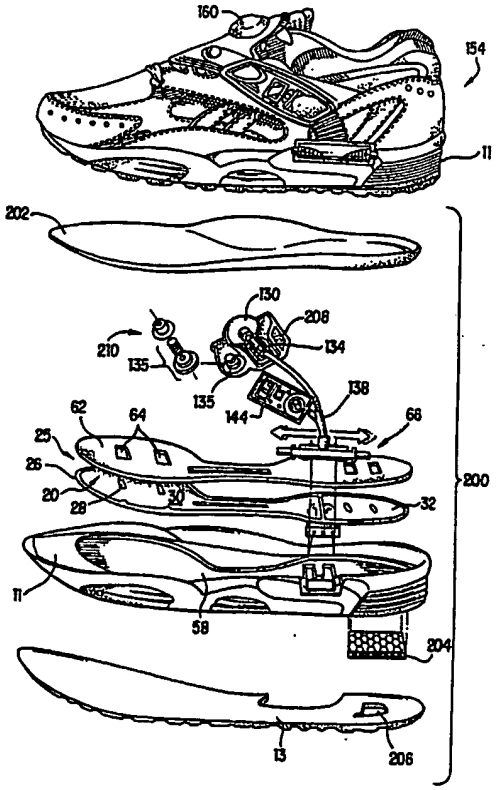
(54) Title: SUPPORT SYSTEM FOR FOOTWEAR

(57) Abstract

Inflatable footwear is disclosed in which an inflatable bag (25) under the foot is formed by two sheets of material welded together. Interior welds (28) are provided to moderate the thickness of the inflatable bag. A foam layer (62) having apertures (64) is positioned adjacent to the inflatable bag. The apertures (64) overlie the interior welds (28, 28') and are sized larger than the interior welds. Also described is a slide valve system (Fig. 11) which enables selective inflation of individual bladder chambers (32, 30).



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TITLE OF THE INVENTION

SUPPORT SYSTEM FOR FOOTWEAR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to footwear and more particularly to an under the foot support system which provides both improved shock absorption (cushioning) and support.

2. Background

The past decade has brought to the forefront the importance of exercise. Commensurate with the public awareness has been a flurry of activity in the development of footwear. One of the problems faced by the footwear industry relates to the physiological variances between people. Thus the requirements of footwear varies from person to person. The Running Shoe Book states, in discussing a study undertaken by the U.S. Army to determine the shape of soldier's feet, that "[p]erhaps the most important finding from this massive survey is contained in the following stodgy 'Army-ese' conclusion: '(to make a single last to fit all men) may not prove possible since it is evident that consistent or orderly schemes of dimensional inter-relationships applicable to all, or even a majority of men, probably do not exist.'"

In the last several years, Reebok International Ltd., the assignee of the present invention, has been successful in alleviating the problems associated with variations in foot shape by providing inflatable technology in the uppers of its shoes. The inflatable technology enables an individual user to custom fit his or her shoe by inflating the upper to fill in

those gaps ordinarily present between the upper and the foot of a wearer. The Reebok inflatable technology, sold under the trademark THE PUMP utilizes a pair of thin sheets of material. The sheets are radio frequency (rf) welded about their periphery to form a substantially air impervious pocket or bag. The sheets are also welded together interiorly to moderate the inflated thickness of the system at selective locations. For example, a series of weld lines or spots may be located in the tongue region of the shoe (where only a small gap is expected between the foot and the shoe). The frequency of weld lines or spots is less in area where larger gaps are expected, for example around the malleoli of the wearer's foot.

It has been known to utilize fluids (gas or liquid) in the sole of footwear. For example U.S. Patent No. 4,610,099 to Signori (the Signori patent) shows a shoe having an inflatable bladder in the sole. The Signori patent provides for the bladder to be inflated using a hypodermic needle insertion. While the device shown by the Signori patent allows a user to customize his or her shoe, the off-board inflation mechanism makes it difficult to inflate the bladder on an as needed basis. Unfortunately, the solution is not to simply slap an on-board inflation mechanism to the shoe. To do so creates extraordinary construction problems. The Signori patent does not address how a custom underfoot system would be adapted for performance in the forefoot. Similar devices are disclosed by U.S. Patent No. 3,120,712 to Menken and U.S. Patent No. 1,069,001 to Guy.

Another illustration of the attempts to utilize a fluid in the sole of a shoe is found in U.S. Patent No. 4,123,855 which utilizes a liquid, e.g. water in an insole. While the material forming the insole is

impervious, such a system does not allow for customization. Other systems which use a large molecule gas to attempt to inhibit diffusion or migration out of a bag under the foot sacrifice customization and do not give the user the availability to vary the pressure of gas within the bag.

The art cited above illustrates the problems associated with utilizing fluid under the foot. Typically, the art has developed in two directions. The first path recognized that the use of a gas such as air in an inflatable system has the potential to diffuse through the bag containing the air. To solve this perceived problem, a large molecule is used which does not diffuse through its container as readily as air. Unfortunately, even if such systems provided adequate support for the wearer, the support could not be varied by the user. Others recognized that providing variable cushioning under the foot was advantageous. What has not been fully appreciated until the advent of the present invention is the need for variable support as well as cushioning.

One of the monumental difficulties in providing a variable support system for under the foot, relates to the difficulties in manufacturing. Specifically, the assignee of the present application has learned from its experiences with inflatable technology that an inflation mechanism should be on-board to maintain maximum convenience for the wearer. In other words, the inflation mechanism, e.g. a butyl rubber bulb, should be physically attached to the shoe. Preferably the inflation mechanism is attached to the upper (as in shoes sold by the assignee under the trademark THE PUMP). Unfortunately, the upper of a shoe and the sole of a shoe are made separately and perhaps even at separate locations. The upper and the sole must then

be assembled to form a shoe. In a inflatable system which is partially located in the upper (the inflation mechanism), partially located under the foot (the inflatable system or bag), and which must have a high degree of integrity (no leaks), the problems of manufacturing are monumental.

Another problem ignored previously relates to flexure of the sole. While it is well known to provide grooves in either the outsole or the midsole of a shoe to enable flexure of the shoe, shoes having inflatable technology have not previously taken necessary steps to ensure proper bending of an inflatable bag located under the foot. Whether an on-board inflation mechanism or a remote inflation mechanism is utilized on an inflatable system for under the foot, it is critical that the system flex in the desired location and that the interior weld lines are positioned in the most anatomical useful locations.

One of the objects of the present invention is to provide a system whereby variable support under the foot is achieved with an on-board inflation mechanism. Another object of the invention is to make such a support system using the anatomical features of the foot as a guide. In the past, systems have had quilting patterns under the foot which bore little relation to the human foot. Thus both static and dynamic comfort were considered in developing the present invention.

SUMMARY OF THE INVENTION

In accordance with the purposes of the present invention as embodied and described herein, the present invention is an athletic shoe which includes an upper and sole. The sole defines a cavity and an

inflation bag is disposed within the cavity. The inflation bag having a welded periphery and having at least one interior weld located within the periphery. An inflation mechanism is provided for delivering fluid to the inflation bag. A foam layer is disposed above the inflation bag and has at least one flexure aperture. The flexure aperture is positioned above the interior weld and is sized such that the flexure aperture fully overlies the interior weld.

In another aspect of the invention a plurality of interior weld lines are utilized.

In yet another aspect of the invention an inflation mechanism is substantially permanently affixed to the upper.

In yet another aspect of the invention an athletic shoe includes an upper and a sole. The sole is attached to the upper and includes a midsole. The midsole defines a posterior cavity disposed substantially under the heel of a wearer and a anterior cavity disposed anteriorly of said posterior cavity. The athletic shoe further includes an inflation system. The system includes a posterior chamber formed from a first sheet of material having a thickness of greater than about 15 mils and a second sheet of material having a thickness of greater than about 15 mils. The first and second sheets are welded together to form the posterior chamber. The posterior chamber is disposed within the posterior cavity. An anterior chamber is provided which is formed from a sheet of material having a thickness of greater than about 15 mils and a sheet of material having a thickness of greater than about 15 mils. The sheets are welded together to form said anterior chamber. The anterior chamber is disposed within said anterior cavity. An inflation mechanism is attached to the

upper and enables selective inflation of one of the chambers via a conduit.

A slider valve is provided which includes a slider housing which defines a substantially cylindrical bore. The slider housing has a valve inlet, an posterior valve outlet and an anterior valve outlet. The valve inlet, the posterior outlet, and the anterior outlet each define passageways which are in fluid communication with the cylindrical bore. A slider piston is disposed within the cylindrical bore and is oriented to enable a user to move the slider piston from a first position and a second position. In the first position, there is a passageway from the valve inlet through the anterior outlet to enable inflation of the anterior chamber. In the second position there is a passageway from the valve inlet through the posterior outlet to enable inflation of the posterior outlet. The piston may also be oriented between the first and second positions, in the "neutral" position where there is no air exchange through the valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

Figure 1 is a top elevation view of a sole depicting one embodiment of the present invention;

Figure 2 is a top elevation of a sole without either the inflation bag or the foam layer of the present invention;

Figure 3 is a cross sectional view of Figure 1 cut along line III-III;

Figure 4 is a cross-sectional view of Figure 1 cut along line IV-IV;

Figure 5 is a bottom view of an embodiment of the inflation bag of the present invention;

Figure 6 is a cross-sectional view of Figure 1 cut along line VI-VI;

Figure 7 is a cross-sectional view of Figure 5, cut along line VII-VII;

Figure 8 is a cross section view of the anterior connector used with the present invention;

Figure 9 is a top view of a connector used with the present invention;

Figure 10 is a cross section of Figure 10 cut along line X-X;

Figure 11 is a top view of an embodiment of a slider valve attached to the connector of Figure 9;

Figure 12 is a top view of one embodiment of the slider valve of the present invention;

Figure 13 is a side view of Figure 12 in the direction of arrow XIII-XIII;

Figure 14 is a front view of one embodiment of the slider valve of the present invention;

Figure 15 is a top view of one embodiment of the lider valve of the present invention with a cutaway to show an embodiment of the slider piston of the present invention;

Figure 16 is a back view of one embodiment of the slider valve of the present invention;

Figure 17 is a back view of one embodiment of the slider valve of the present invention;

Figure 18 is a top view of a retaining bracket for use with the present invention;

Figure 19 is a side view of Figure 18;

Figure 20 is a cross sectional view of Figure 11 cut along line XX;

Figure 21 is a front view of one embodiment of the slider valve of the present invention with a cutaway to show an embodiment of the slider piston of the present invention;

Figure 22 is the same as Figure 21 except the valve is set to a different fluid flow path;

Figure 23 depicts one embodiment of a slider piston of the present invention;

Figure 24 depicts one embodiment of a slider valve and pressure transducer circuit of the present invention;

Figure 25 depicts a pressure transducer with digital readout used with the present invention;

Figure 26 is a depiction of an inflation mechanism used with the present invention;

Figure 27 is a left side view of an athletic shoe incorporating the present invention;

Figure 28 is an exploded perspective view of a sole incorporating one embodiment of the present invention;

Figure 29 is a shoe incorporating the present invention and an exploded view of one aspect of the inventor;

Figure 30 is a shoe incorporating the present invention and an exploded view of one aspect of the invention; and

Figure 31 is a shoe incorporating the present invention and an exploded view of one aspect of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings, Figure 1 is a top elevational view of an athletic shoe sole incorporating the support system of the present invention. The shoe sole, designated generally as 10,

has a heel region 12, a forefoot region 14 and an arch region 16. The heel region of sole 10 generally underlies the calcaneus of the foot of a wearer. Similarly, the forefoot region is generally that region in the anterior most portion of the sole. The forefoot region underlies the metatarsal heads and the region anterior of the metatarsal heads. Similarly, the arch region is that portion of the shoe which generally underlies the arch of the wearer. It should be noted that there are no discrete lines which form the boundaries of the three above-mentioned regions.

Figure 1 is a sole for use on the left foot of a wearer. The sole for use on the right foot may be a mirror image of that shown in Figure 1.

The sole of Figure 1 includes several components: a midsole 11, an inflation bag 25 which lies in a cavity in the midsole; and a foam layer 62. The cavity 58, seen best in Figure 2, includes a posterior cavity 59, an anterior cavity 60, and a connector cavity 61, which will be discussed in more detail below. The depth of the posterior cavity 59 and the anterior cavity 60 is approximately 1/8 inch and is substantially uniform. Naturally other applications may dictate variations in the dimensions of the cavities. The connector cavity 61 has a depth of approximately 1/4 inch. These dimensions can be seen by reference to Figures 3 and 4, which are cross-sections of Figure 1 cut along lines III-III and IV-IV, respectively. The depth of the anterior cavity is designated by D_a and the depth of the connector cavity is designated by D_c. Fitting within the posterior cavity 59, and the anterior cavity 60, is an inflation bag 25. Figure 5 is a depiction of the bottom view of the inflation bag 25 along with a connector body 50. The inflation bag 25 along with the connector body 50 fit within the posterior cavity 59, the anterior

cavity 60, and the connector body cavity 61. The system shown in Figure 5 is inverted and laid on top of the sole 10 shown in Figure 2.

As best seen in Figures 3, 4 and 6, the sole 10 forms a plurality of cavities. The sole may be made of any conventional material used for making soles. In particular, the sole may have a midsole 10 formed from a cushioning material and an abrasive-resistant outsole 13. The midsole may be made of a material such as foam PU or EVA and the outsole may be made of a conventional rubber. Lying within a posterior cavity 59 and an anterior cavity 60 is the inflation bag 25.

Referring to Figure 5, the bottom view of an inflation bag 25 is shown. The inflation bag is formed from a first sheet 22 and a second sheet 24 (see Figure 7). The first sheet 22 and the second sheet 24 are welded about their periphery with a periphery weld 26. Preferably the sheets forming the inflation bag are made of Pellethane 2355 95 AE available from Dow Chemical Company having a thickness of approximately 19 mils (19/1000 inch). It is preferable that the thickness of the sheets be greater than 15 mil. Interior welds 28 are also provided. The location of the interior welds 28 are selected to function in accordance with the anatomical features of the foot. The two interior welds in the heel region 28' provide a landing zone. To determine the location of the interior welds 28, anatomical landmarks were identified.

Weld notches 27 are provided in the forefoot region 14 to encourage flexing along lines L1 and L2. Flexure is further encouraged by providing flexure apertures 64 in the foam layer 62. These flexure apertures 64, seen best in Figure 1, overlie all or some of the interior welds 28. In the metatarsal

region, flexure is facilitated by the combination of interior welds (preventing inflation) and flexure apertures 24 (decreasing stiffness). Typically when welding two sheets together, one sheet will remain substantially planar while the other will have weld depressions as shown in Figure 7. It is preferable that the flat sheet (24 in Figure 7) be the upper surface of the inflation bag 25. Note that because Figure 5 is a bottom view of the inflation bag 25, Figure 7 appears to show the upper surface with depressions. It is preferable that the depressions formed by welds 28 be on the lower surface of the inflation bag 25.

With continuing to Figure 5, a separation weld 34 is provided to separate the inflation bag 25 into an anterior chamber 30 and a posterior chamber 32. Welded to the anterior chamber is an anterior connection 36. Similarly, a posterior connection 38 is welded to the posterior chamber. A first weld flange 40 is provided around the anterior connection 36. Similarly, a second weld flange 42 is provided around the posterior connection 38. Figure 6 is a cross-section of Figure 1 cut across the anterior connection 36 and the posterior connection 38. Figure 8 shows a cross-section of the anterior connection 36. The posterior connection 38 may be identical to that of the anterior connection 36.

The anterior connection 36 defines an interior connection lumen 44, best seen in Figure 8. The posterior connection 38 defines an interior connection lumen 44'. An anterior tube 46 is inserted in the lumen 44. Similarly, a posterior tube 48 is inserted into the posterior connection lumen.

A connector body 50 is either attached to both the anterior tube 46 and the posterior tube 48 or formed monolithic therewith. The inflation bag 25,

the anterior connection 36, the posterior connection 38, and the connector body 50 form a substantially integral unit. In one embodiment of the invention, this unit is a substantially permanently affixed unit which is not intended to be dismantled by the consumer. Naturally, modifications are possible which would allow the consumer to remove and replace component parts.

As described previously, the inflation system 20 is inserted into the cavities shown in Figure 2 and is affixed thereto by an adhesive. A foam layer 62 is then adhered to the top of the inflation bag 25. Figure 1 shows the top view of the sole, the inflation bag 25, and the foam layer 62. It should be noted that the connector cavity 61 has a first hollow 63a and a second hollow 63b which are intended to accommodate the anterior connection 36 and the posterior connection 38.

Turning to some of the specifics of the connector body 50, and with particular reference to Figures 9-10 it is anticipated that the front face 51 of connector body 50 would be flush with the exterior of the midsole. The connector body 50 defines an anterior inlet lumen 52 and a posterior inlet lumen 54. The anterior inlet lumen 52 is aligned with the anterior tube 46 and the lumen 44 of the anterior connection to provide a fluid path from the front face 51 of the connector body 50 to the interior of the inflation bag 26. A similar arrangement is provided with respect to the posterior inlet lumen 54. The connector body is provided with a central barb receptacle 56, as will be described in more detail below.

Attached to the connector body 50 is a slider valve 66 which selectively allows fluid to be introduced into either the anterior chamber 30 or the

posterior chamber 32. Figure 11 is a depiction of the slider valve 66 attached to connector body 50. A central barb 128 formed integrally with the slider valve 66 is inserted into and through the central barb receptacle 56. Once inserted, the geometry of the central barb 128, namely the "arrow" shape of the distal end of central barb 128, prevents the dislocation of the slider valve 66 from the connector body.

Referring now to Figures 12-23, the slider valve for use in the present invention will be described. Figure 12 is a top view of the entire slider valve 66. As will be described in detail below, fluid enters valve inlet 70 (in the direction into the page in Figure 12) and selectively exits either the anterior barb outlet 124 or the posterior barb outlet 126. The barbs are put on the anterior barb outlet and the posterior barb outlet in order to prevent back leakage through the connector.

Figure 13 is a side view of Figure 12 in the direction of arrow XIII of Figure 12 and Figure 14 is a front view of Figure 12. Figure 15 is substantially the same as Figure 12 except that Figure 15 has cut away a portion of the valve housing to expose a slider piston 82. In addition, Figure 15 differs from Figure 12 in that Figure 15 shows slider piston 82 and the retaining bracket 112 affixed thereto selectively moved to a position to allow fluid communication from the inlet 70 to the posterior barb outlet 126. Conversely in Figure 12 the slider valve 66 is oriented to allow fluid communication from inlet 70 to anterior barb outlet 124. Figure 16 shows the back of the slider valve 66 without the retaining bracket 112. Figure 18 shows a top view of the retaining bracket 112, *per se*. As will be explained in more detail below, retaining bracket 112, snaps into a

first bracket retaining means 90 and a second bracket retaining means 94 on the slider piston 82. Figure 19 is a side view of the retaining bracket 112. As seen in this figure the retaining bracket 112 is geometrically configured with retaining clamps 114, 116 to snap onto the first bracket retaining means 90. Naturally both retaining clamps 114, 116 of the retaining bracket 112 may be configured identically. Figure 17 is identical to Figure 16 except that retaining bracket 112 has been affixed by snapping the retaining clamps 114, 116 onto the first bracket retaining means 90 and the second bracket retaining means 94 of the slide piston 82. Figure 20 is a cross section of Figure 11 cut along line XX-XX. Figure 20 shows the attachment of the outlet of the slider valve 66 and the connector 50.

Figures 21 and 22 depict a cutaway view of the slider valve 66 in its two different positions. Figure 22 is identical to Figure 14 except that Figure 22 has a cutaway portion to see expose slider piston 82.

Figure 23 shows the slider piston 82 *per se*. As will be explained, this slider piston 82 is inserted in the central bore 80 defined by the cylindrical body 74 of the housing 68 of slider valve 66. The slider piston 82 may be moved freely along the longitudinal axis of the central bore 80. The retaining bracket 112 (seen in Figure 22, for example) defines the extent to which the slider piston 82 moves.

Referring again generally to Figures 12-23, the details of the slider valve 66 are herein described. The slider valve, designated generally as 66, includes a housing 68. The housing 68 has a vertically disposed post or valve inlet 70. The valve inlet 70 leads to a generally cylindrical body 74 which has a

first end 76, a second end 78, and defines a central bore 80. Disposed within central bore 80 is a slider piston 82. Figure 23 shows slider piston 82 *per se*, while Figures 15, 21 and 22 show a cutaway of the cylindrical body 74 which shows the slider piston 82 in place. Referring specifically to Figure 23, the slider piston 82 has a first end member 84 and a second end member 86. The first end member 84 and the second end member 86 have diameters which are substantially the same as the inside diameter of central bore 80, with enough tolerance to allow the slider piston 82 to be moved along the longitudinal axis of the central bore 80. A first annular disk 88 helps define a first bracket retaining means 90. Similarly, a second annular disk 92 helps to define a second bracket retaining means 94.

When the slider valve 66 is assembled, the slider piston 82 is inserted in the cylindrical body 74. A bracket 112 is then attached to the slider piston 82 as best seen in Figures 12 and 15. The bracket 112, seen *per se* in Figure 18, has a first retaining clamp 114 and a second retaining clamp 116. The first retaining clamp 114, a side view of which is seen in Figure 19, is inserted in the first bracket retaining means 90 while the second retaining clamp is inserted in the second bracket retaining means 94. When the bracket 112 is attached to the slider piston 82, it is possible to move the piston and attached bracket 112 back and forth from the position shown in Figure 21 to the position shown in Figure 22. The bracket 112 has projections 120 (seen best in Figure 18), which cooperate with projections 122 on the cylindrical body. The bracket projections 120 mate with the cylindrical body projections 122 to inhibit the bracket from moving angularly about the cylindrical body 74. In other words, the bracket 112 does not

rotate relative to either the cylindrical body 74 or the slider piston 82.

Figure 16 shows the cylindrical body 74 with the slider piston inserted within the central bore 80. Figure 17 is identical to Figure 16, except that the bracket has been inserted within the first bracket retaining means 90 and the second bracket retaining means 94. In operation, the slider valve 66 is movable between two positions shown in Figures 21 and 22, respectively. When the slider piston 82 is moved to the position shown in Figure 21, air entering the valve inlet 70 enters the central bore 80 and flows left through a posterior barb outlet 126. Figure 15 is identical to Figure 21, except that Figure 15 is a top view and Figure 21 is a front view. As seen in either Figures 15 or 21, fluid flows into valve inlet 70 and out of the posterior barb outlet 126. O-rings 104, 106, 108 and 110 help prevent leaking and help to assure that the flow is directed in the desired manner. Figure 22 is identical to Figure 21, except that the slider piston 82 has been moved along the central bore 80. In the orientation of Figure 22, fluid flows through the valve inlet 70 and into the central bore 80. Because of the location of the O-rings, the fluid entering the valve inlet 70 exits the anterior barb outlet 124.

Referring to Figure 11, the slider valve 66 is shown attached to the connector body 50. The anterior barb outlet 124 is inserted in the anterior inlet lumen 52 and the posterior barb outlet 126 is inserted in the posterior inlet lumen 54. A central barb 128 is inserted in a corresponding central barb receptacle 56 in the connector body 50.

It is intended that once the slider valve 66 has been connected to the connector 50, they will be

permanently attached and cannot be disassembled by the user. As will be discussed later, the purpose of the connection is to enable ease of manufacture.

In operation, a latex bulb or the like is used as an inflation mechanism to selectively inflate either the posterior chamber or the anterior chamber. An inflation mechanism, such as the one described in co-pending patent application 07/588,828 (same assignee as the present application), the disclosure of which is herein incorporated by reference, delivers air through a one-way valve to a tube. Other inflation mechanisms such as a molded urethane dome shaped mechanism may also be used to deliver air. Similarly, a portable pressurized gas canister may also be used to deliver gas such as CO_2 to the chambers. One end of the tube is attached downstream of the one-way valve, and the other end of the tube is connected to the valve inlet 70. The user may selectively inflate either the posterior chamber or the anterior chamber, depending on the position of the slider piston 82 within the cylindrical body 74.

One of the advantages of the above-described construction is that the upper may be constructed with a substantially permanently affixed inflation mechanism. Similarly, the sole may be constructed. After the sole and the upper are attached, the only additional operation is to insert the barbs of the slider valve 66 into the connector body 50.

In another aspect of the invention, a pressure transducer is placed in the circuit between the mechanism used to inflate the inflation bag 25 and the slider valve 66.

Figure 24 depicts one possible embodiment of the fluidic circuitry utilized when using a pressure transducer. Figure 24 shows the system from the back side, i.e., that side not seen in use. Figure 27, in

contrast, shows the system as it appears on a shoe. An inflation mechanism 130 is depressed by the user, thereby displacing air from the inflation mechanism. A one-way valve 134 is located downstream of inflation mechanism 130 to prevent air from returning to the inflation mechanism. One possible one-way valve 134 is depicted in Figure 26 (a cross-section of the inflation mechanism and one-way valve arrangement). As seen in this Figure the one-way valve is substantially bill-shaped. This bill-shaped arrangement only allows air to pass through the one-way valve 134 in the direction away from the inflation mechanism 130. A second one-way valve 136 allows ambient air to fill up the inflation mechanism 130 after the inflation mechanism has been depressed.

A release mechanism 135 (of the type described in co-pending patent application 07/588,828) is in fluid communication downstream of one-way valve 134 in order to selectively release air from one or both inflation chambers.

Air which is displaced from the inflation mechanism is passed through delivery tube 132 to the slider valve 66 via a Y-shaped connector 138. An arm 140 of the Y-shaped connector is attached to barb attachment 142 of a pressure transducer or pressure gauge 144. The electronic air pressure gauge 144 may be used to measure the pressure within any of the inflation systems described herein. It may be used whether the inflation system is inflated using an on-board inflation mechanism or an off-board mechanism (such as a pressurized CO_2 cartridge). When used in a cushioning system with a diverter valve (slider valve 66), the gauge 144 measures the pressure in the chamber open to the inflation mechanism.

The gauge is arranged downstream of the inflation mechanisms, and upstream of the actual air bag, it is

arranged within the system so that the gauge display can be positioned on the shoe in a location which is easily visible to the user. The tubing connecting the gauge 144 to the inflation mechanism/inflation system should be kept as short as possible to keep the overall system volume as small as possible, and to limit the volume of the entire system. The gauge should sample at least every 0.8 seconds, often enough to register the increases one would expect to see with each stroke of the inflation mechanism 130. The display need not display in conventional units such as pound per square inch (psi). The display may be an arbitrary scale created to give the user enough resolution to establish whether the right and left shoes will feel the same as they did when the user last undertook the same activity. In one embodiment, the scale displayed represents pressures from 0 to 30 psi on a 0.0 to 9.5 linear scale with steps of 0.5. It is preferable that the accuracy be at least $\pm$ 3 psi over a temperature range of 0^0 F to 110^0 F. The electronics must use power efficiently enough to have battery which will outlast the life of the shoe and be smaller than a diameter of approximately 12 mm.

In a preferred embodiment the pressure gauge 144 has the following characteristics:

1. **measuring range:** 0-30 psi display range, handles pressure up to 70 psi;

2. **readout type:** digital LCD which indicates pressure range. Range span 0.0 to 9.5 in 0.5 linear increments. Display should remain illuminated for 60 seconds after the activation button 201 is released and should sample the pressure at least every 0.8 seconds;

3. **accuracy:** +- 3 psi down to 0^0 F and up to 110^0 F;

4. **storage temperature:** -10^0 F to 140^0 F;

5. **battery life:** minimum 2 years assuming 4 uses per day every day for 2 years;
6. **unit size:** 22 x 43 x 10 mm;
7. **water resistancy:** 50 meters water resistancy using watch industry standards;
8. **shock resistancy:** unit should withstand a meter drop (using watch industry standards) as well as be able to handle vibrational shock of 30 Hz; and
9. **weight:** approximately 10 grams maximum.

The transducer 144 (the front of which is shown in Figure 25) has a digital read out 145 and may give a pressure read out in real or arbitrary units of measurement. The pressure transducer allows a user to consistently inflate the inflation bag or bags to the desired pressure. The Y-connector 138 is attached at one end to the valve inlet 70 of slider valve 66. As previously described, air entering the slider valve will inflate either the anterior chamber or posterior chamber of the inflation bag, depending on the position of the slider valve.

In Figure 24, it can be readily seen that the slider valve is positioned within a valve housing 146. The ends of the valve housing 146 have openings which allow the end member 86 to extend therethrough, thereby providing a "button" which can be pushed to move the valve from one position to the next. By pushing the end member 86, the slider piston 82 moves and end member 84 is exposed. Thus, the user can readily select whether to inflate the anterior chamber or the posterior chamber of inflation bag 25.

The pressure transducer is positioned in a transducer housing 150. As shown in Figure 27, the transducer housing 150 may be stitched to the upper 152 of shoe 154. An accordion connector 156 may

join the transducer housing 150 and the valve housing 146.

Turning specifically to Figure 27, a shoe 154 is provided with an upper 152, a midsole 11 and an outsole 13. The transducer housing 150, which houses and protects pressure transducer 144, is stitched to upper 152 and may provide eyelets 158 at one end thereof. The inflation mechanism may underlie the inflation mechanism cover 160 located at the digital end of tongue 162.

A release mechanism (not shown) for releasing air from the inflation bag may be located anywhere downstream of the one-way valve 134. Co-pending patent application 07/588,828 (previously incorporated by reference) discloses a suitable release valve.

One advantage of the arrangement of the elements as shown in Figure 27 is that the upper 152 may be manufactured (along with the inflation mechanism and the slider valve 66) independently of the sole. Similarly, the sole may be manufactured independently of the upper. The upper 152 and the sole may then be joined in a conventional manner. The central barb 128 along with the anterior barb outlet 124 and posterior barb outlet of the slider valve 66 are then inserted into the connector 50 to complete the fluid circuit. The accordion connector 156 allows for slight variations in the location of the sole relative to the upper without fear of integrity lapses in the fluidic circuit.

While the invention described above utilizes a posterior chamber and an anterior chamber under the foot of the wearer, in one variation of the invention, an inflation bag having a single chamber is utilized. In this embodiment, shown in Figure 28, a sole 164 is provided with a midsole 166 and an abrasive resistant outsole 168. A first cavity 170 is provided with a

depth sufficient to accommodate a forefoot inflation bag 172 and a foam layer 174. A second cavity 176 is provided with sufficient depth to accommodate an angled connector member 178. The angle connector member provides an inlet for inflating the forefoot inflation bag 177. In one embodiment, the angle connector member 178 may include a connector such as that which is shown in Figure 8. The angle connector member 178 may further include an angle portion as shown in Figure 28. The angled portion and connector (similar or identical to the one depicted in Figure 8) may be monolithic or attached via a small tube.

The forefoot inflation bag 172 is formed in substantially the same manner as the inflation bag described previously having an anterior chamber and a posterior chamber. The forefoot inflation bag 172 is formed by rf welding together two sheets of material about the periphery of the sheets. The sheets are approximately 19 mil and are made of Pellethane 2355 95AE available from Dow Chemical Company. The characteristic feature of this sheet material is that it initially stretches a slight amount. After the initial stretching, the material is relatively non-stretching.

Within the interior of the forefoot inflation bag 172 are interior welds 180 which promote flexing at desired locations. When the two sheets are welded together, a depression is created in one of the sheets (as seen in Figure 7). It is preferable that the sheet having the depression be the lower sheet. This helps to promote flexing. The foam layer 176 defines flexure apertures 182 which completely overlie the area of the interior welds 180.

In operation, an inflation mechanism, such as the one disclosed in co-pending patent application 07/588,828 is attached via a tube to the angled

connector, to selectively inflate the forefoot inflation bag.

Referring now to Figures 29-31, several implementations of the present invention are shown. At the top of each of Figures 29-31 is a depiction of the appearance of the overall shoe 154 incorporating different aspects of the invention. What lies below the shoe 154 is an exploded depiction of the inflation system of each shoe and its incorporation with other sole features. The entire underfoot cushioning system along with all the ancillary underfoot components are designated generally as 200.

The system depicted in Figure 29 is substantially the same as that depicted in Figures 1-26. An exploded view is provided to better show how the components previously described fit together. A conventional sockliner 202 overlies the system as previously described. As previously described, an inflation system is provided with two chambers and a valve to selectively inflate either the anterior chamber 30 or the posterior chamber 32. Also shown in Figure 29 is the use of a honeycomb cushioning material 204 which may be viewed through an opening 206 in outsole 13.

The release valve 135 and inflation mechanism 130 are mounted on a base 208 which comprises two sheets of film welded together. A passageway may be provided between the sheets to allow fluid communication between the region underlying the release valve and at a point downstream of one-way valve 134.

A plastic adapter or release valve cover 210 may be placed over the release valve 135. The release valve cover 210 serves two purposes, to protect the release valve 135 and to act as an adapter to enable the inflation bag 25 to be inflated using a portable gas canister such as a pressurized CO_2 canister.

Thus, the user has the option of inflating the inflation bag 25 with either the on-board inflation mechanism 130 or the portable gas canister (not shown). One possible canister and release valve cover 210 is described in co-pending U.S. patent application serial no. 07/828,440, filed on January 31, 1992 having inventors Legassie *et al* and being assigned to the assignee of the present invention. The disclosure of this patent application is hereby incorporated by reference.

Figure 30 depicts another adaptation of the invention. The cushioning system of Figure 30 is generally the same as that described previously with reference to Figure 28. An outsole 168 is provided with openings 206 for viewing a honeycomb cushioning material 204. In addition, a foam piece 212 may be provided to cover the angled connector member 178. Figure 30 also shows an inflation mechanism 130 and release valve 135 in fluid communication with forefoot inflation bag 172 via tube 214.

Figure 31 shows yet another possible implementation of the invention. This system is similar to the system of Figure 30 except that a rearfoot inflation bag 216 is employed. The rearfoot inflation bag 216 is constructed in substantially the same manner as the previously described inflation bags. Interior welds 218 are provided in the rearfoot inflation bag 216 and apertures 220 are provided in a foam member 222 overlying the inflation bag 216. As with other embodiments, an angled connector member 178 may provide an inlet for air delivered from the inflation mechanism 130. As with the devices shown Figures 29 and 30 a release valve cover 210 may be provided over a release valve 135 to enable the rearfoot inflation bag 216 to be inflated with a pressurized gas canister.

Figure 31 also shows an outsole 13. A clear rubber dome member 224 is provided which allows observation of the rearfoot air bag from the bottom of the shoe. The clear dome member 224 is formed from molded rubber having sufficient optical clarity to view the inflation bag 216. The molded rubber member 224 extends from the exterior of the shoe all the way through to the inflation bag 224. Naturally, a clear member 224 or similar viewing mechanism may be used in any of the above-described embodiments to view the various inflation bags previously described.

The foregoing description of the preferred embodiments of the invention have been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit it to the precise form disclosed. Obviously, many modifications and variations may be made in light of the above teachings. For example, although the invention has been discussed in the context of athletic footwear, it is possible to adopt the invention for use in other types of athletic equipment such as baseball gloves and other protective equipment; ski boots; helmets and the like.

The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended thereto.

WE CLAIM:

1. An athletic shoe, comprising:

(a) an upper;

(b) a sole, said sole being attached to said upper and including a midsole, said midsole defining a posterior cavity disposed substantially under the heel of a wearer and an anterior cavity disposed anteriorly of said posterior cavity; and

(c) an inflation system including:

a posterior chamber formed from a first sheet of material and a second sheet of material, said first and second sheets being welded together to form said posterior chamber, said posterior chamber disposed within said posterior cavity;

an anterior chamber formed from a third sheet of material and a forth sheet of material, said third and fourth sheets being welded together to form said anterior chamber, said anterior chamber disposed within said anterior cavity;

an inflation mechanism attached to said upper;

a conduit, said conduit having an inlet and an outlet, the inlet of said conduit being oriented to receive fluid from said inflation mechanism;

a slider valve, said slider valve comprising a slider housing defining a substantially cylindrical bore, said slider housing having a valve inlet, a posterior valve outlet and an anterior valve outlet, said valve inlet, said posterior outlet, and said anterior outlet each defining passageways which are in fluid communication with the cylindrical bore; said slider valve having means to enable the user to selectively block the fluid path to either of said posterior valve outlet or said anterior valve outlet.

2. The athletic shoe of claim 1 wherein said means to enable the user to selectively block the fluid path includes a slider piston disposed in said substantially cylindrical bore.

3. The athletic shoe of claim 2 wherein said piston has a plurality of O-rings disposed thereon.

4. The athletic shoe of claim 1 wherein said first sheet of material has a thickness greater than about 15 mils.

5. The athletic shoe of claim 4 wherein said second, third and fourth sheets have a thickness of greater than about 15 mils.

6. The athletic shoe of claim 1 wherein at least one of said first, second, third and forth sheets of material has a thickness of about 19 mils.

7. The athletic shoe of claim 1 wherein said posterior chamber is formed from sheets comprising urethane.

8. The athletic shoe of claim 1 wherein said anterior chamber is formed from sheets comprising urethane.

9. The athletic shoe of claim 1 wherein said inflation mechanism comprises a butyl rubber bulb.

10. The athletic shoe of claim 1 wherein said inflation mechanism is substantially permanently attached to said upper.

11. The athletic shoe of claim 1 wherein said inflation mechanism comprises a pressurized CO_2 canister.

12. Footwear, comprising: an upper and a sole, said sole defining a cavity and including a ground engaging first surface formed from a substantially wear resistent material; an inflation bag, said inflation bag being disposed within the cavity formed by said sole, said inflation bag having a welded periphery and having at least one interior weld located within the periphery of said inflation bag; an inflation mechanism for delivering fluid to said inflation bag; and a foam layer disposed above said inflation bag, said foam layer defining at least one flexure aperture, said at least one flexure aperture being positioned above said at least one interior weld, wherein substantially the entire interior weld is overlain by said flexure aperture.

13. Footwear as defined by claim 12, further comprising an upper, wherein said inflation mechanism is substantially permanently affixed to said upper.

14. Footwear as defined by claim 12, wherein said inflation bag is located substantially under the heel of the wearer in use.

15. Footwear as defined by claim 14, comprising a plurality of interior welds located within said periphery.

16. Footwear as defined by claim 12, comprising a plurality of interior welds located within said periphery.

17. Footwear as defined by claim 16, wherein said interior welds are disposed at a location which promotes flexure of the sole in a region generally underlying the metatarsal heads of the wearer.

18. Footwear as defined in claim 12, wherein said inflation bag includes weld notches.

19. Footwear as defined in claim 15 wherein said weld notches are oriented to promote flexure of said inflation bag in a region generally underlying the metatarsal heads of a wearer.

20. Footwear as defined in claim 12 wherein said inflation bag comprises a material which initially stretches and then substantially maintains its shape.

21. Inflatable athletic equipment comprising an inflatable bag, said inflatable bag having internal welds to moderate the thickness of said inflatable bag and a foam layer disposed adjacent said inflation bag, said foam layer defining flexure apertures having a perimeter wherein each of aid internal welds underlie a corresponding one of said flexure apertures and said welds completely underlie the area of the apertures.

22. Inflatable athletic equipment of claim 21 wherein said athletic equipment is footwear.

23. Inflatable athletic equipment of claim 21 wherein said athletic equipment is a glove.

AMENDED CLAIMS

[received by the International Bureau on 27 May 1993(27.05.93);
original claims 12 and 21 amended;
new claims 24 and 25 added;
other claims unchanged (5 pages)]

1. An athletic shoe, comprising:

(a) an upper;

(b) a sole, said sole being attached to said upper and including a midsole, said midsole defining a posterior cavity disposed substantially under the heel of a wearer and an anterior cavity disposed anteriorly of said posterior cavity; and

(c) an inflation system including:

a posterior chamber formed from a first sheet of material and a second sheet of material, said first and second sheets being welded together to form said posterior chamber, said posterior chamber disposed within said posterior cavity;

an anterior chamber formed from a third sheet of material and a forth sheet of material, said third and fourth sheets being welded together to form said anterior chamber, said anterior chamber disposed within said anterior cavity;

an inflation mechanism attached to said upper;

a conduit, said conduit having an inlet and an outlet, the inlet of said conduit being oriented to receive fluid from said inflation mechanism;

a slider valve, said slider valve comprising a slider housing defining a substantially cylindrical bore, said slider housing having a valve inlet, a posterior valve outlet and an anterior valve outlet, said valve inlet, said posterior outlet, and said anterior outlet each defining passageways which are in fluid communication with the cylindrical bore; said slider valve having means to enable the user to selectively block the fluid path to either of said posterior valve outlet or said anterior valve outlet.

2. The athletic shoe of claim 1 wherein said means to enable the user to selectively block the fluid path includes a slider piston disposed in said substantially cylindrical bore.

3. The athletic shoe of claim 2 wherein said piston has a plurality of O-rings disposed thereon.

4. The athletic shoe of claim 1 wherein said first sheet of material has a thickness greater than about 15 mils.

5. The athletic shoe of claim 4 wherein said second, third and fourth sheets have a thickness of greater than about 15 mils.

6. The athletic shoe of claim 1 wherein at least one of said first, second, third and fourth sheets of material has a thickness of about 19 mils.

7. The athletic shoe of claim 1 wherein said posterior chamber is formed from sheets comprising urethane.

8. The athletic shoe of claim 1 wherein said anterior chamber is formed from sheets comprising urethane.

9. The athletic shoe of claim 1 wherein said inflation mechanism comprises a butyl rubber bulb.

10. The athletic shoe of claim 1 wherein said inflation mechanism is substantially permanently attached to said upper.

11. The athletic shoe of claim 1 wherein said inflation mechanism comprises a pressurized CO_2 canister.

12. Footwear, comprising: an upper and a sole, said sole defining a cavity and including a ground engaging first surface formed from a substantially wear resistant material; an inflation bag, said inflation bag being disposed within the cavity formed by said sole, said inflation bag having a welded periphery and having at least one interior weld located within the periphery of said inflation bag; an inflation mechanism for delivering fluid to said inflation bag; and a foam layer disposed above said inflation bag, said foam layer defining at least one aperture, said at least one aperture being positioned above said at least one interior weld, wherein substantially the entire interior weld is overlain by said aperture.

13. Footwear as defined by claim 12, further comprising an upper, wherein said inflation mechanism is substantially permanently affixed to said upper.

14. Footwear as defined by claim 12, wherein said inflation bag is located substantially under the heel of the wearer in use.

15. Footwear as defined by claim 14, comprising a plurality of interior welds located within said periphery.

16. Footwear as defined by claim 12, comprising a plurality of interior welds located within said periphery.

17. Footwear as defined by claim 16, wherein said interior welds are disposed at a location which promotes flexure of the sole in a region generally underlying the metatarsal heads of the wearer.

18. Footwear as defined in claim 12, wherein said inflation bag includes weld notches.

19. Footwear as defined in claim 15 wherein said weld notches are oriented to promote flexure of said inflation bag in a region generally underlying the metatarsal heads of a wearer.

20. Footwear as defined in claim 12 wherein said inflation bag comprises a material which initially stretches and then substantially maintains its shape.

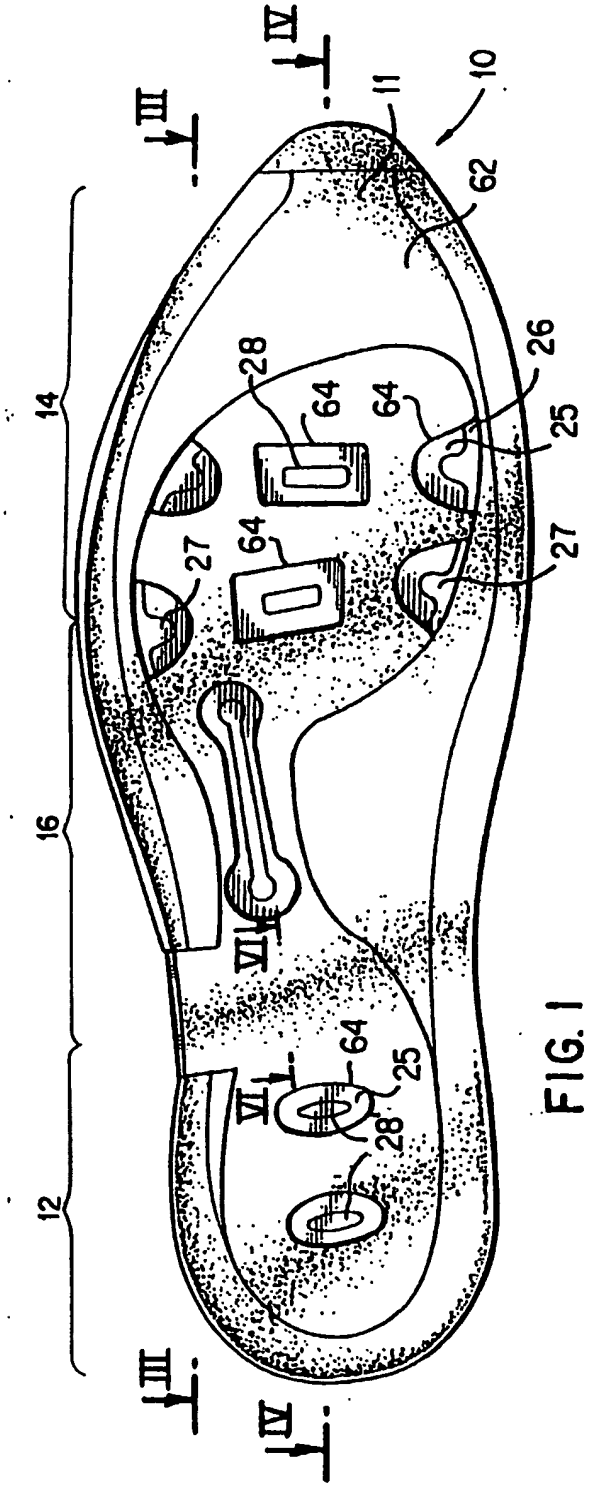
21. Inflatable athletic equipment comprising an inflatable bag, said inflatable bag having internal welds to moderate the thickness of said inflatable bag and a foam layer disposed adjacent said inflatable bag, said foam layer defining apertures having a perimeter wherein each of said internal welds underlie a corresponding one of said apertures and said welds completely underlie the area of the apertures.

22. Inflatable athletic equipment of claim 21 wherein said athletic equipment is footwear.

23. Inflatable athletic equipment of claim 21 wherein said athletic equipment is a glove.

24. Footwear as defined by claim 12, wherein said apertures facilitate flexing of said foam layer.

25. Inflatable athletic equipment of claim 21, wherein said apertures facilitate flexing of said foam layer.


IV
III
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14
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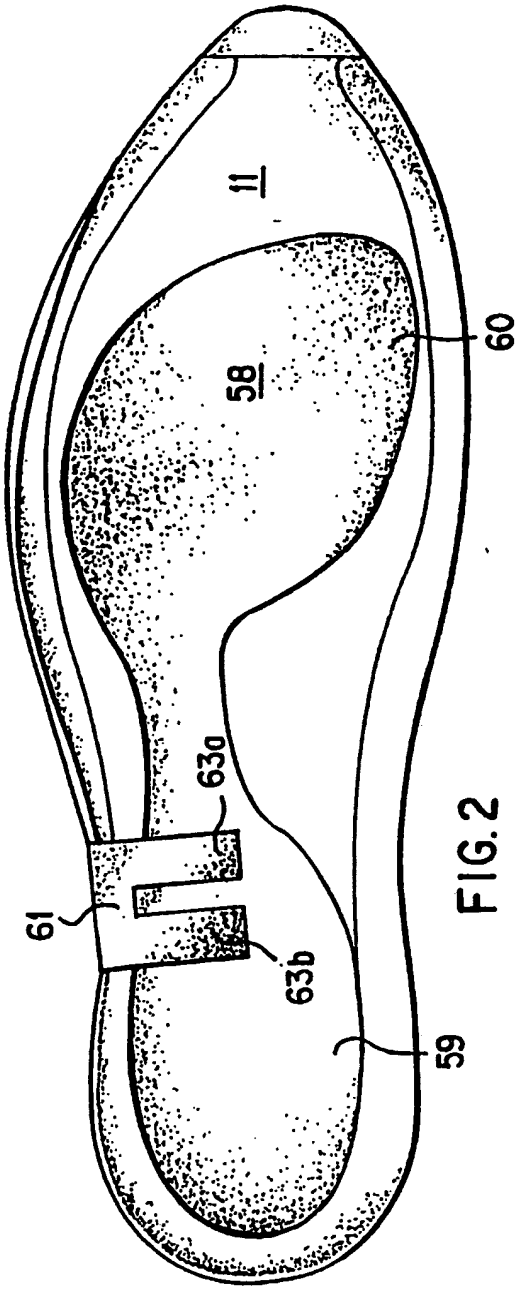
16
VI
64
25
VI
28
12
III
IV

FIG. 1


11
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63a
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63b
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FIG. 2

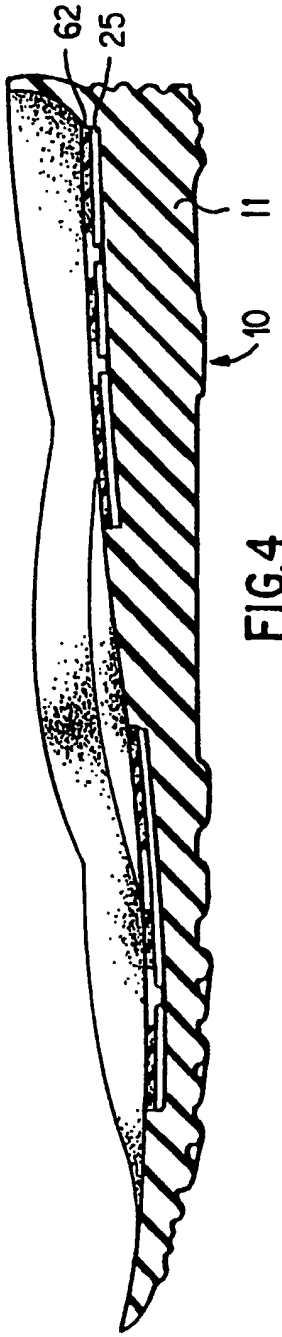

FIG.4

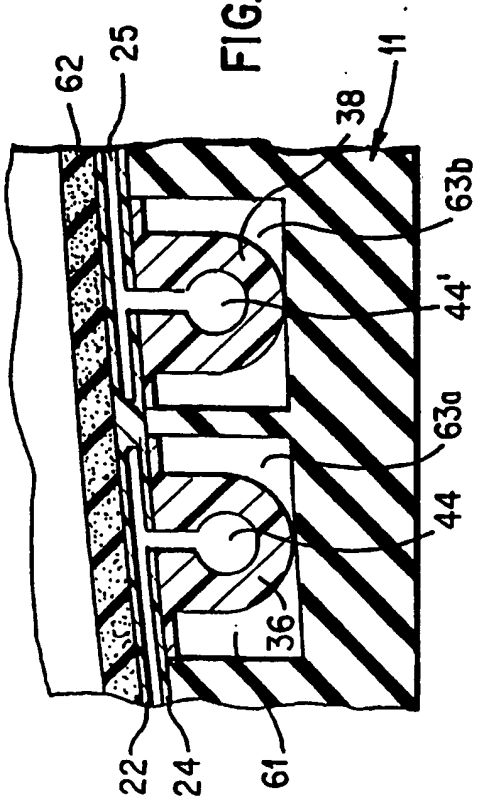

FIG.6

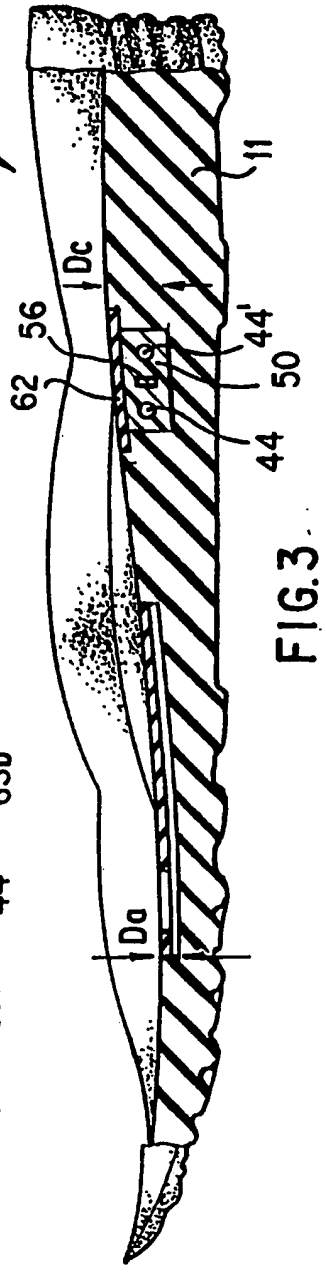

FIG.3

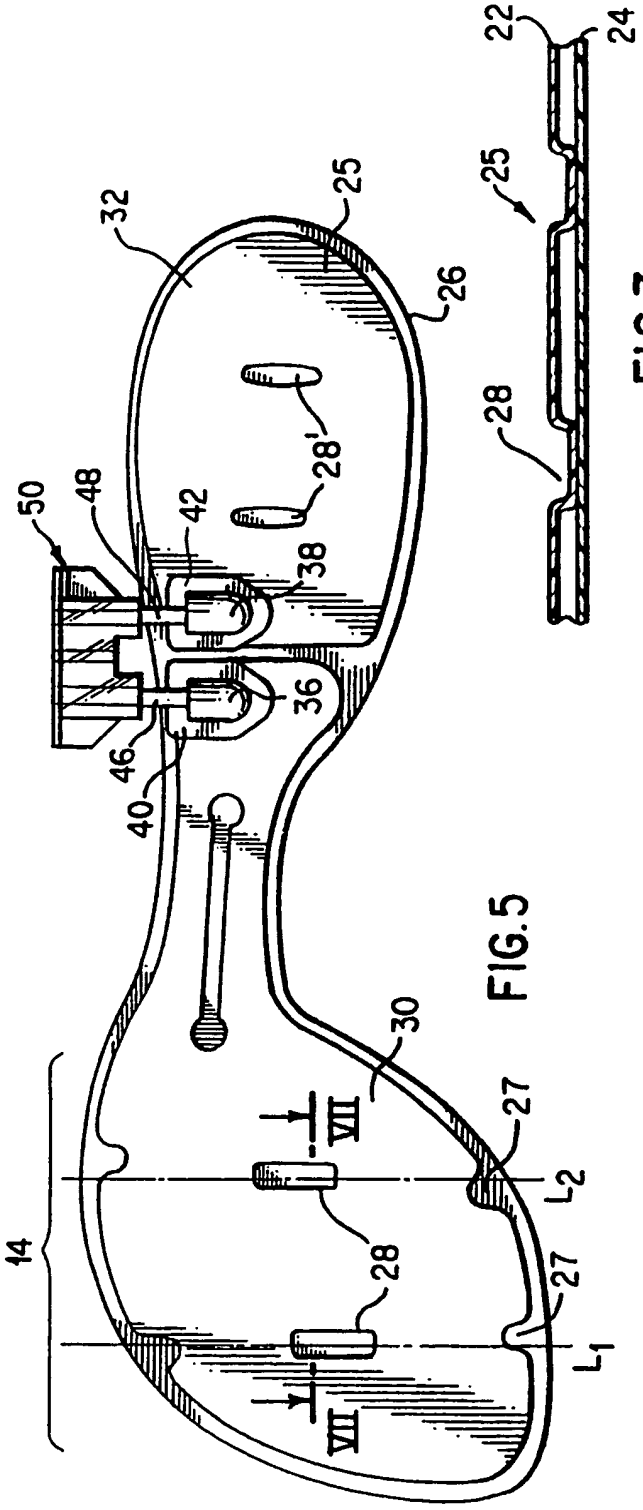

FIG.5

FIG.7

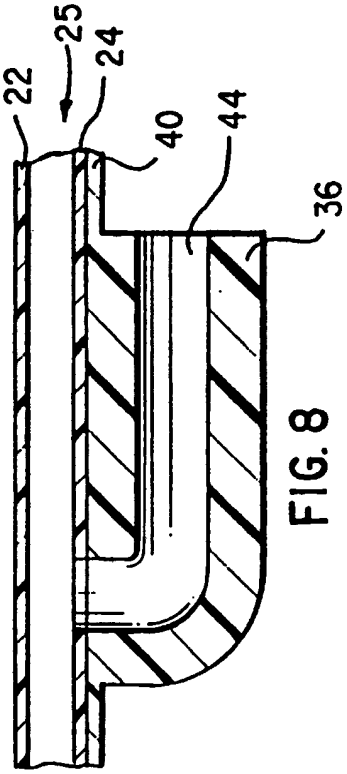

FIG.8

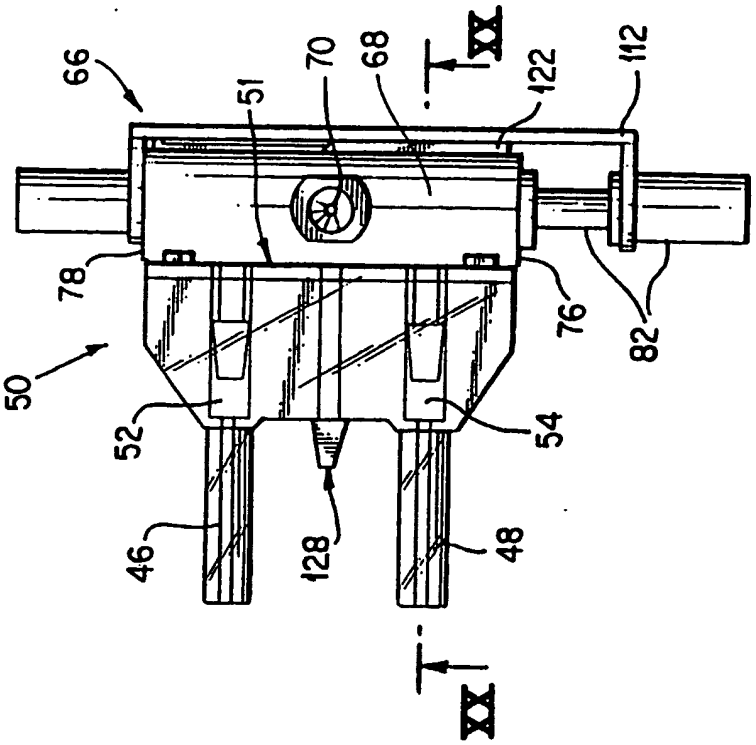

FIG. 11

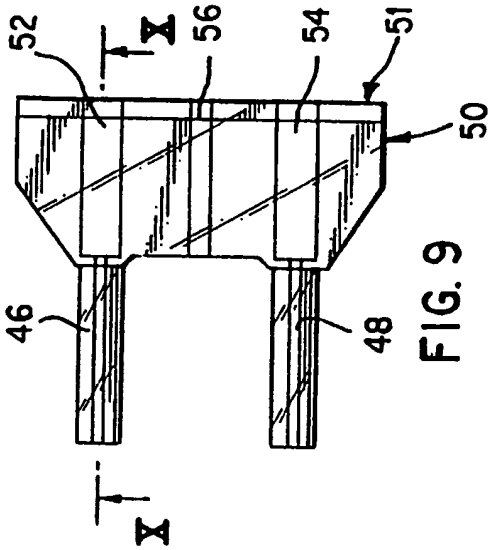

FIG. 9

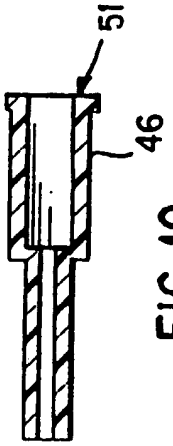

FIG. 10

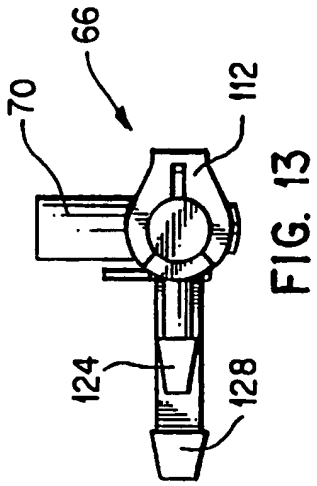

FIG. 13

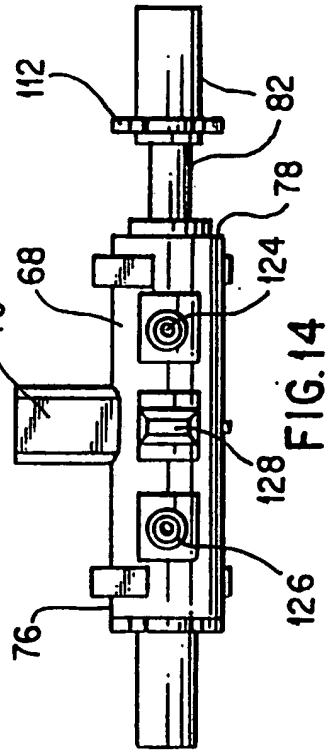

FIG. 14

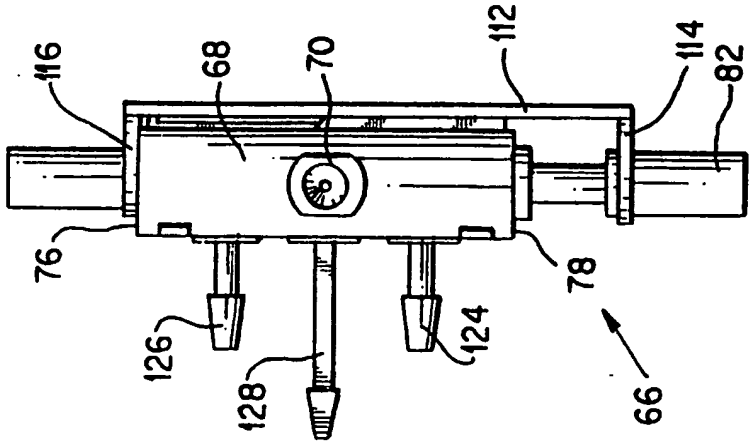

FIG. 12

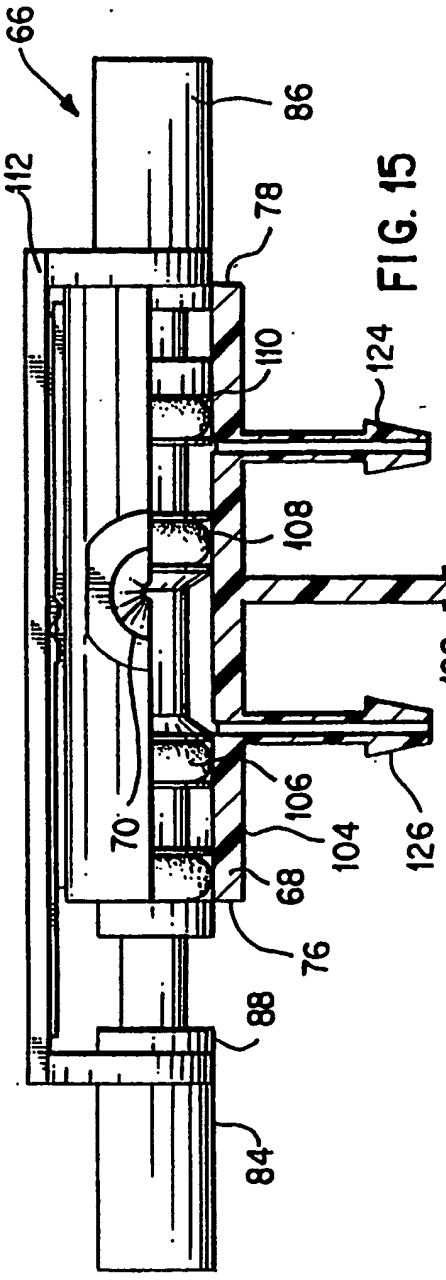

FIG. 15

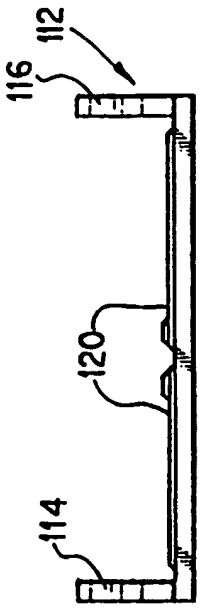

FIG. 18

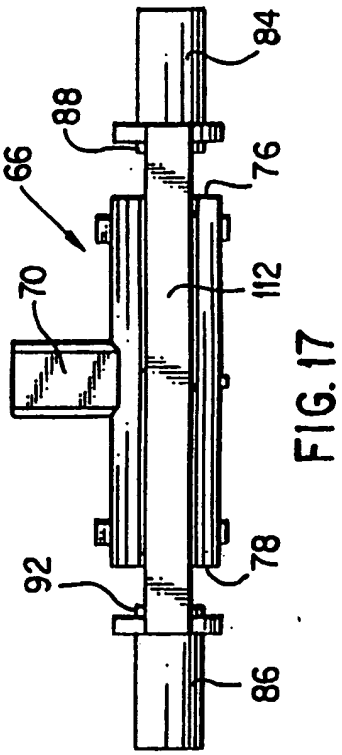

FIG. 17

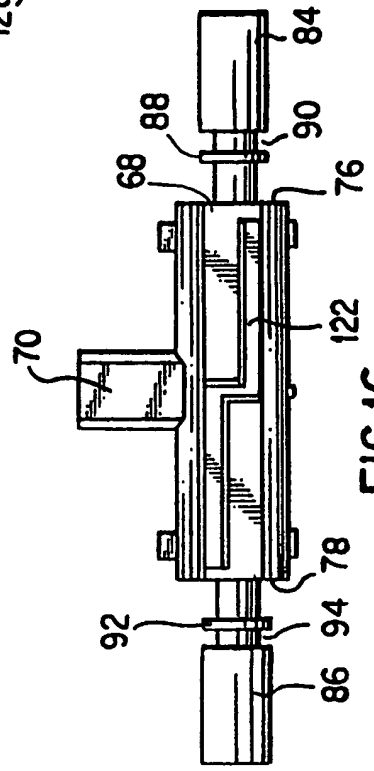

FIG. 16

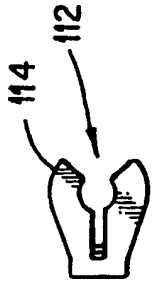

FIG. 19

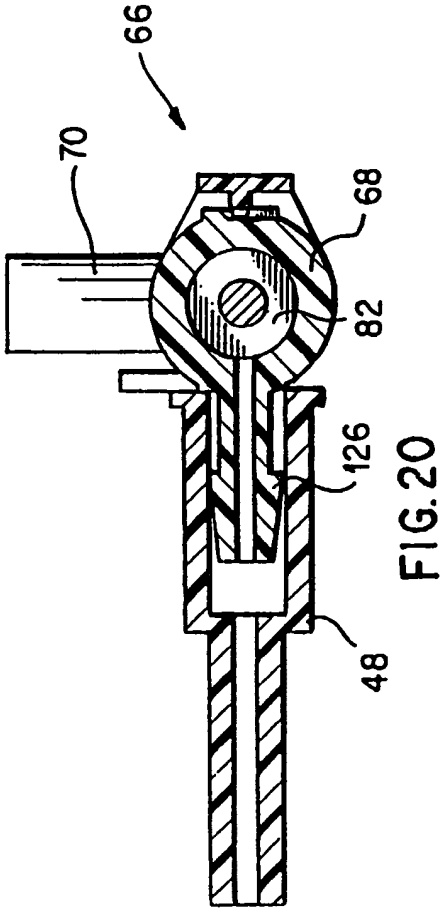
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FIG. 20

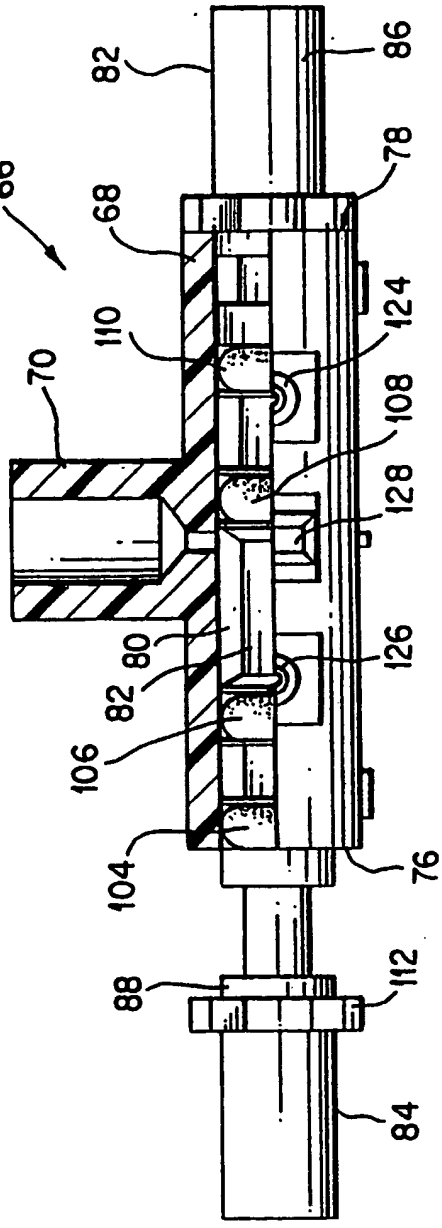
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FIG. 21

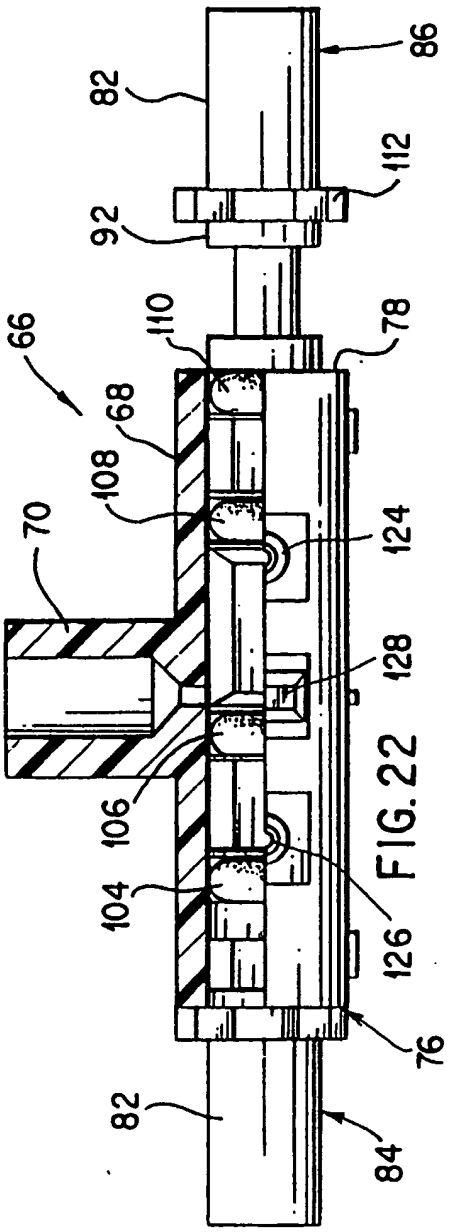
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FIG. 22

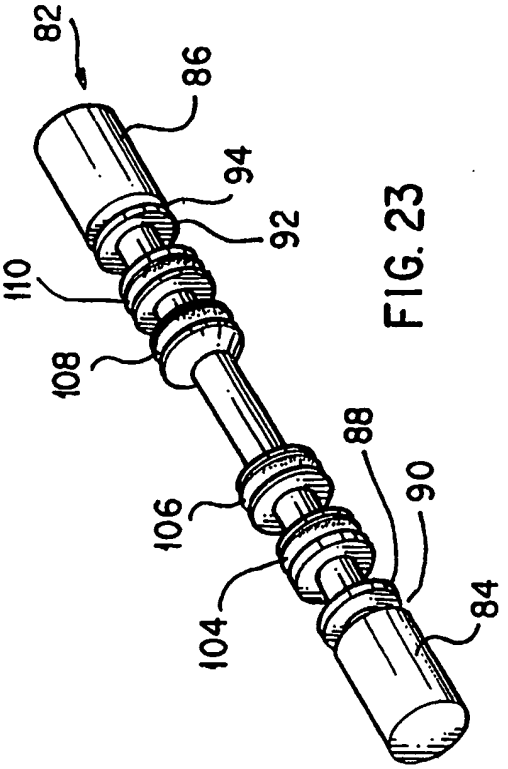
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FIG. 23

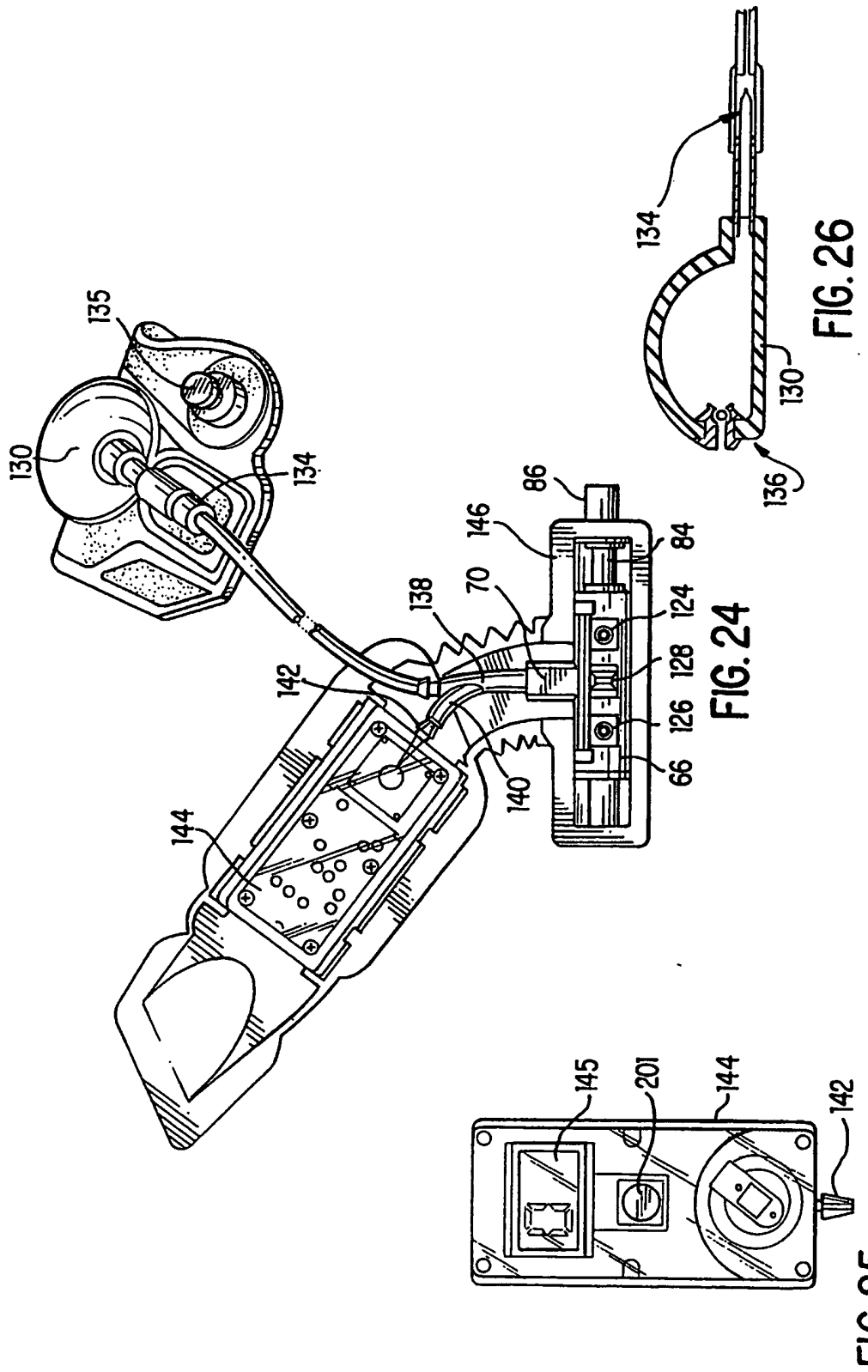


FIG. 24

FIG. 26

FIG. 25

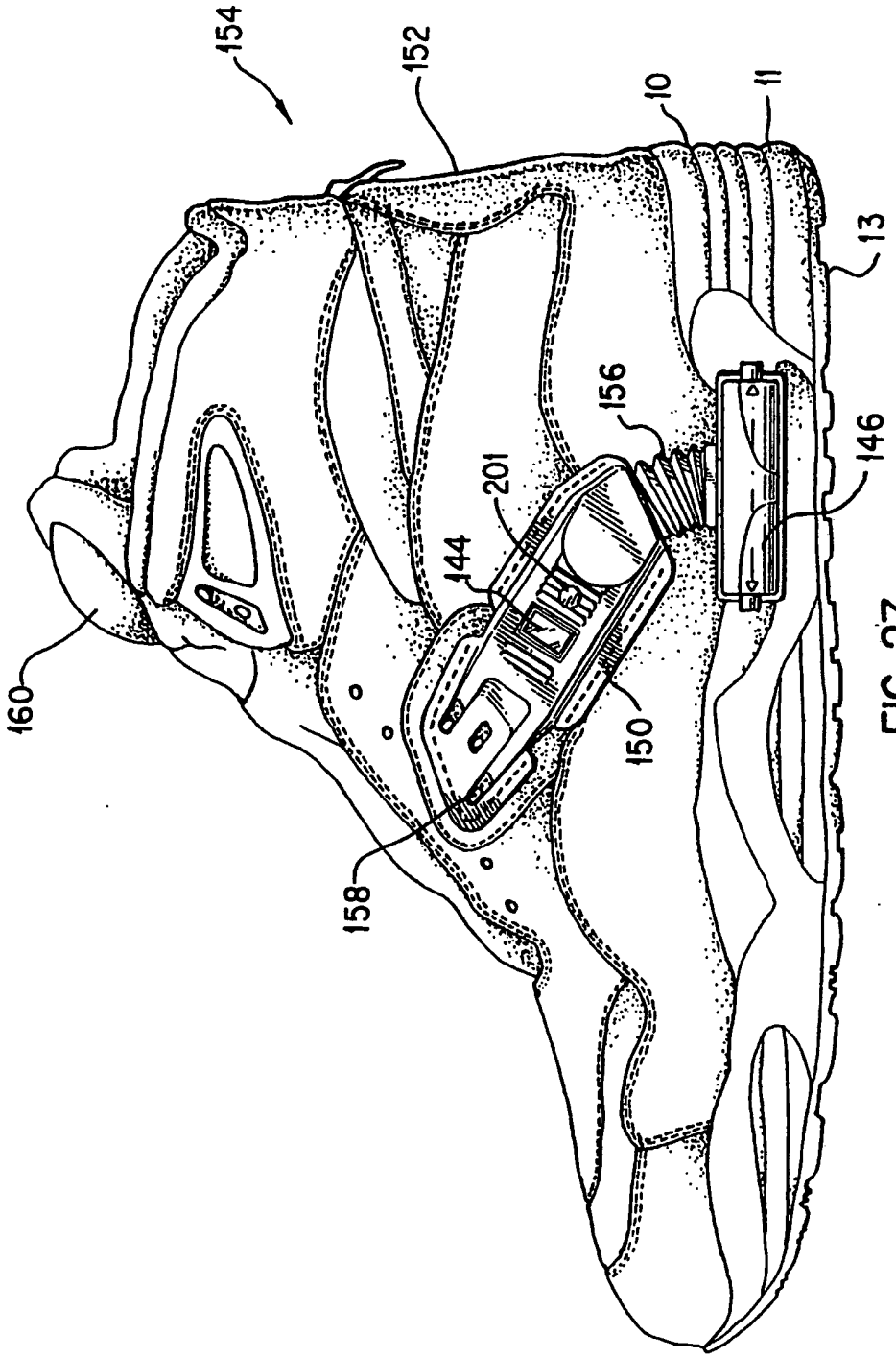


FIG. 27

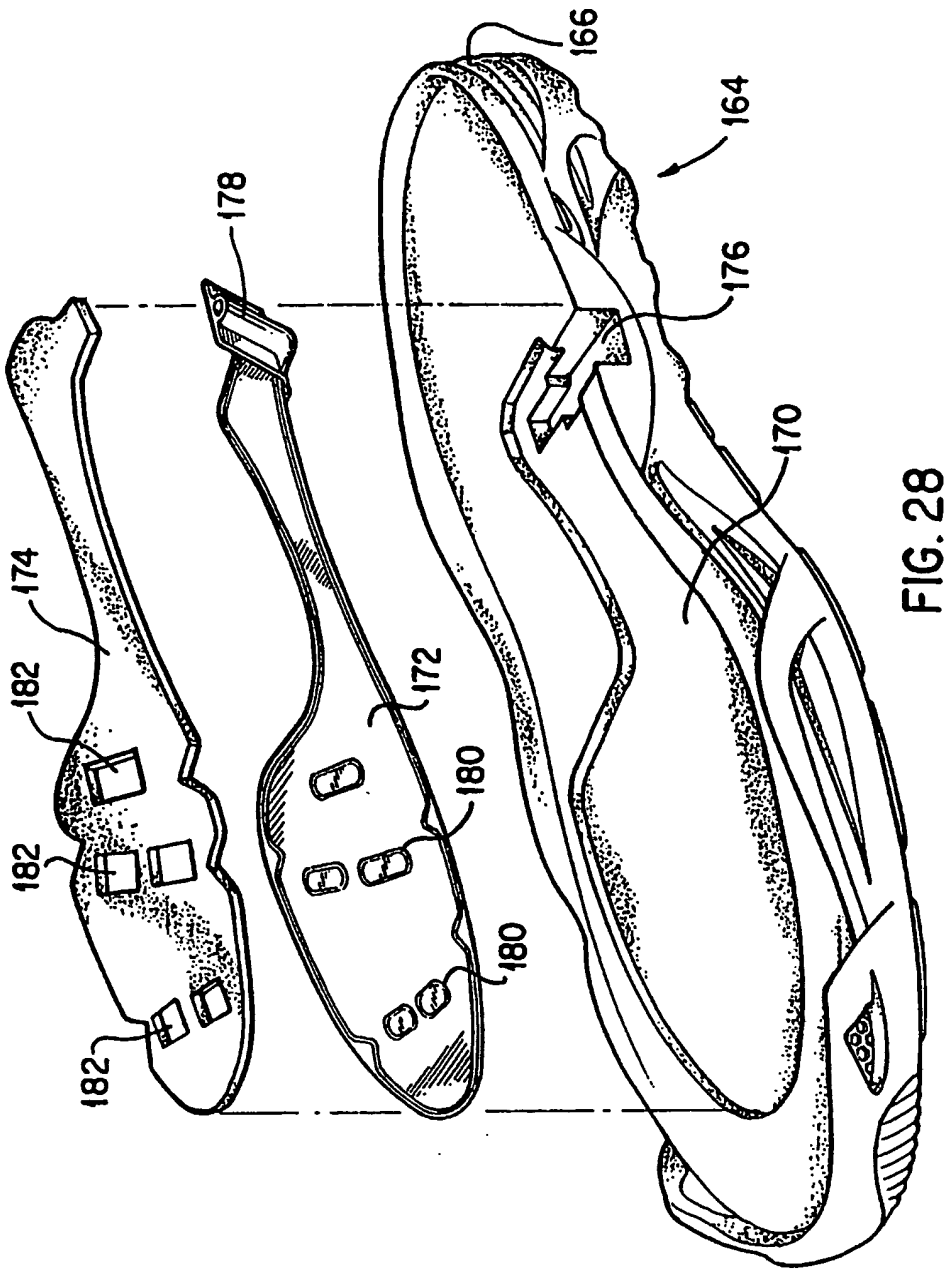
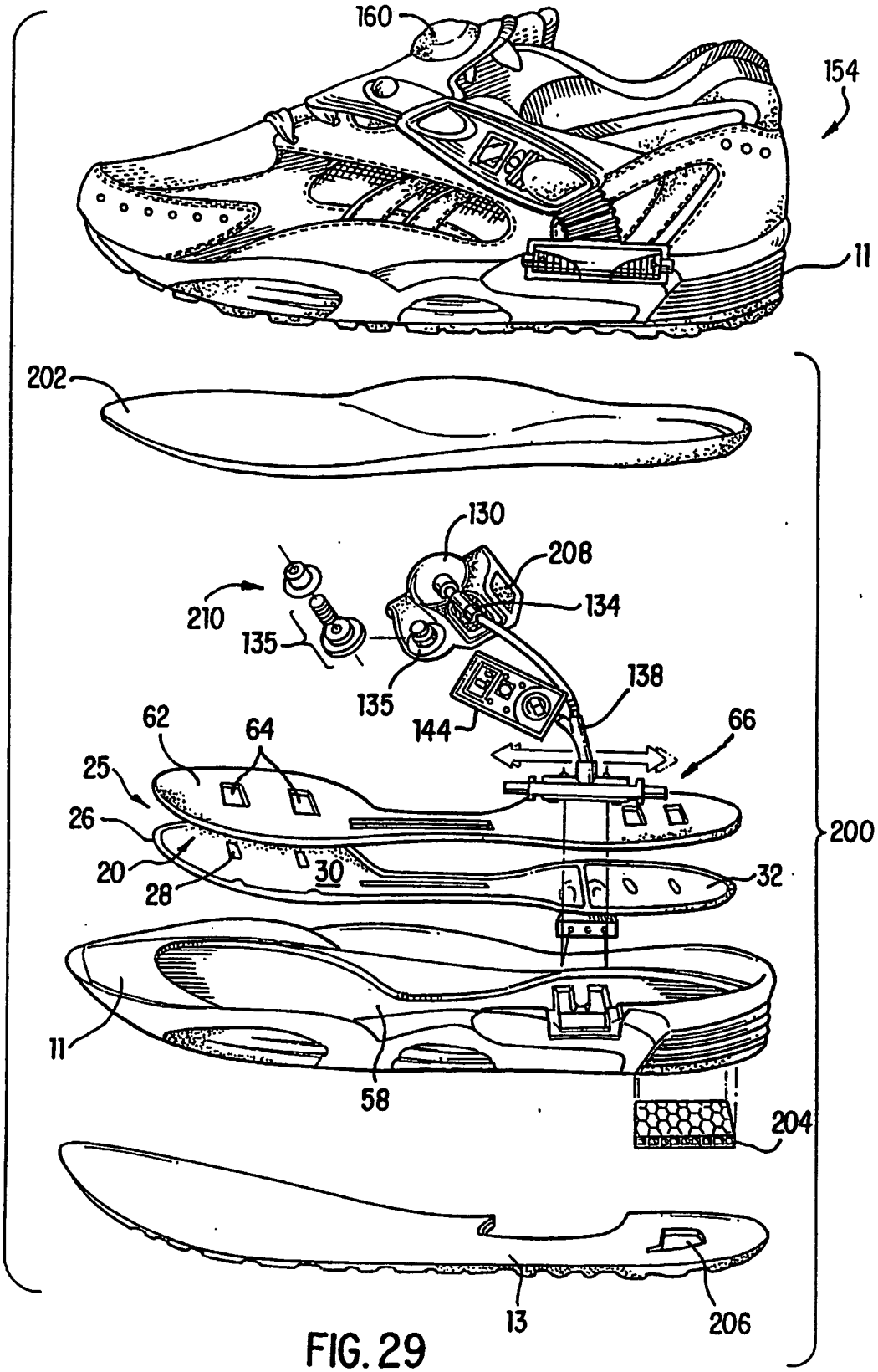


FIG. 28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154
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204
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206

FIG. 29

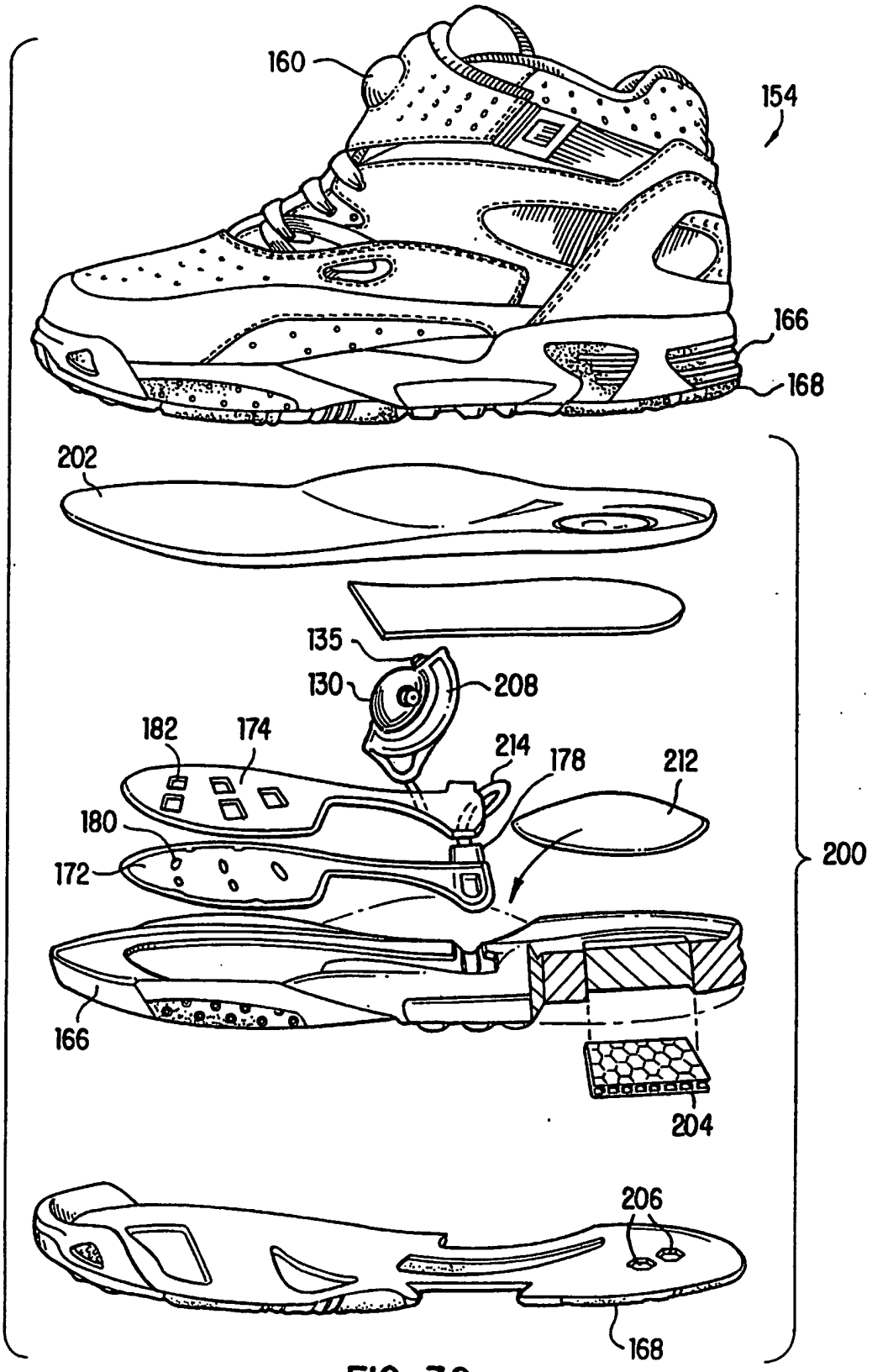
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FIG. 30

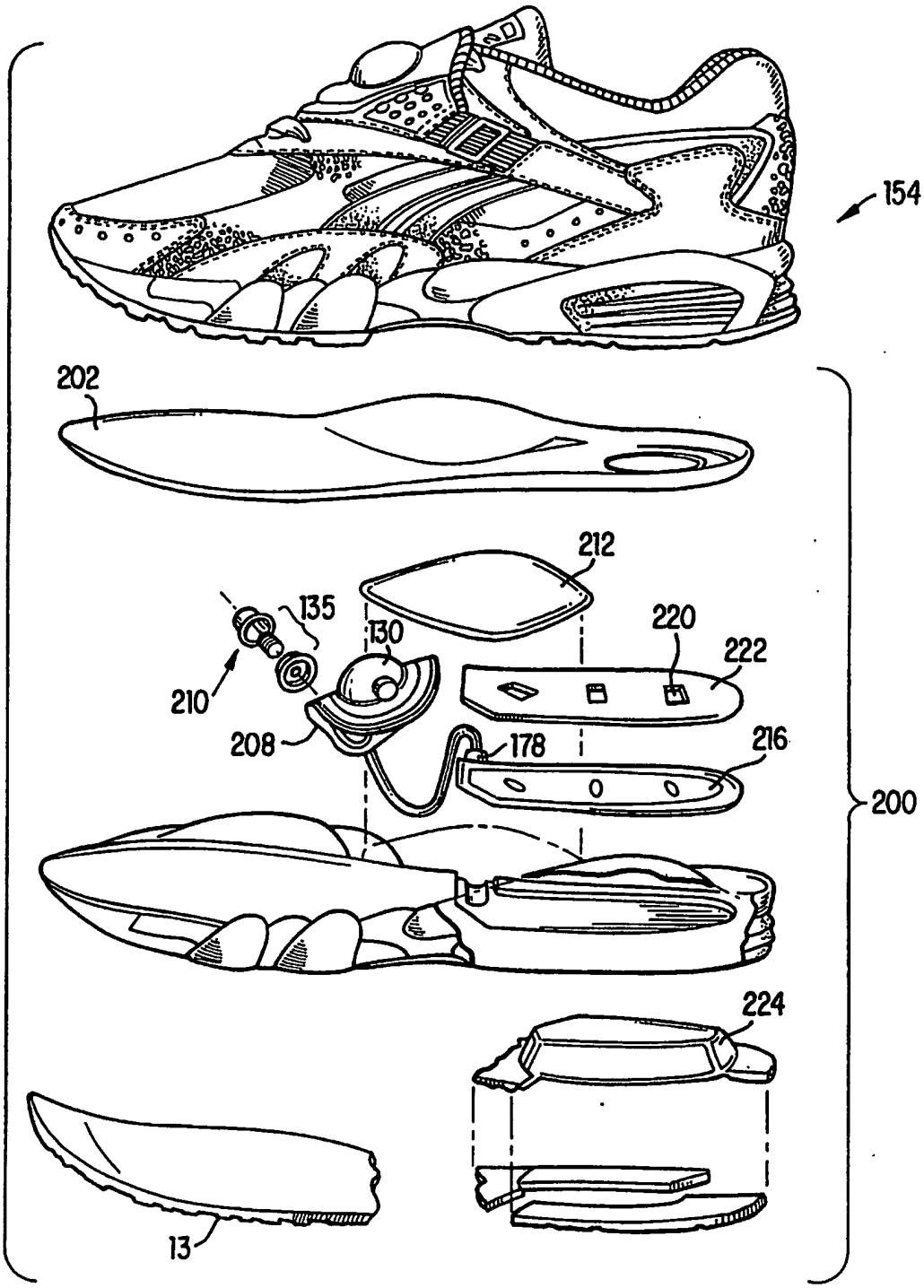

FIG. 31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/10338

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A43B 13/20
US CL :36/029.000

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 36/88,71; 137/625.480,862; 251/319

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS: CARBON DIOXIDE, BLADDER, INFLATE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 1,069,001 (GUY) 29 July 1913, See figs. 1-4.	1,4-8,10
Y	US, A, 3,211,164 (BENDER ET AL.) 12 October 1965, See fig. 2.	1-3
Y	US, A, 3,685,176 (RUDY) 22 August 1972, See entire document.	1,4-8,10,11
Y	US, A, 3,993,099 (NIGHTINGALE) 23 November 1976, See fig. 1.	1-3
Y	US, A, 4,232,459 (VACCARI) 11 November 1980, See entire document.	1,9,10

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 MARCH 1993	14 APR 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer BETHANNE C. CICCONI Telephone No. (703) 308-0771

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/10338

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,446,634 (JOHNSON ET AL.) 08 May 1984, See entire document.	1,4-8
A	US, A, 2,605,560 (GOUABAULT) 05 August 1952.	
A	US, A, 3,854,228 (CONROY) 17 December 1974.	
A	US, A, 3,985,155 (NIGHTINGALE) 12 October 1976.	
A	US, A, 4,219,945 (RUDY) 02 September 1980.	
A	US, A, 487,057 (CHRISTENSEN) 31 October 1989.	
A	US, A, 5,060,694 (FLORIDA ET AL.) 29 October 1991.	
A	US, A, 5,074,765 (PEKAR) 24 December 1991.	